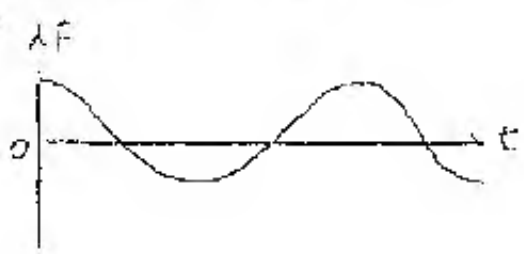


1. (a) (i) At equilibrium, length submerged =  $x_0$   
 $Ax_0(1000)g = A(0.20)(800)g$   
 $x_0 = 0.16 \text{ m}$  1
- (ii) Suppose the object is submerged for length  $x + x_0$ .  
 Resultant force =  $A(0.20)(800)g - A(x + x_0)(1000)g$  1  
 $= -kx$  1  
 (another mark for -ve sign) 1
- (iii)  $\Delta F$   
 1  
 sine curve  
 $t = 0, \Delta F$  at max  
 (+ve or -ve) 1
- (iv)  $\ddot{x} = -kx \quad \therefore T = 2\pi\sqrt{m/k} = 2\pi\sqrt{\frac{16}{1000}} \text{ s}$  1  
 $\approx 0.79 \text{ s}$  or  $0.80 \text{ s}$  1
- (v) Max. amplitude =  $0.20 - 0.16 = 0.04 \text{ m}$  1  
 Beyond this, the cylinder is completely submerged;  
 restoring force ceases to be proportional to  $x$ . 1
- (vi) In a wide container, KE (water) can be neglected;  
 $PE(\text{cylinder}) + KE(\text{cylinder}) + PE(\text{water}) = \text{constant}$ . 1
- (b) (i) Damped SHM  
 energy transformed to internal energy of water and  
 cylinder, temperature rises. 1
- (ii) System unstable : any deviation from vertical  
 not subject to restoring torque. 1  
 Cylinder would fall over and end up floating  
 on its side. 1

2. (a)

$$pV = nRT$$

$$(1.01 \times 10^5) \frac{m}{(1.43)} = (8.31)(273)$$

$$m = \frac{(8.31)(273)(1.43)}{(1.01 \times 10^5)} = 0.0321 \text{ kg}$$

(b) (i)

$$p = p_1 + p_2$$

$$pV = p_1 V_1 + p_2 V_2$$

$$(20 \times 10^5)(0.5) = (10^5)(5) + p_2(0.5)$$

$$p_2 = 5 \times 10^5 \div 0.5 = 10^6 \text{ Pa}$$

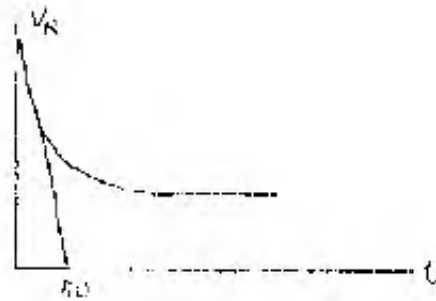
$$(ii) (20 \times 10^5)(0.5) = (10^5)(V_1) + (10^5)(0.5)$$

$$V_1 = 9.5 \text{ m}^3$$

(iii) If very slow inflation  
permits heat exchange with surroundings  
 $\therefore$  temperature constant

3. (a) The 2 beams of light travel different paths  
 constructive interference for p.d. =  $m\lambda$  and  
 destructive interference for p.d. =  $(m + 1/2)\lambda$  } 1
- (b) Change in optical p.d. =  $2t (n - 1)$   
 $= m\lambda$  1
- $$t = \frac{1 \times 480}{2 \times 0.45} \text{ nm}$$
 1
- $$= 3730 \text{ nm}$$
 1
- (c) (i) As  $M_2$  is moved, path difference between the 2 beams  
 is increased; a shift of fringes is observed. } 1
- (ii)  $2d = m\lambda$  1
- $d = \frac{800}{2} \times 480 \text{ nm} = 0.192 \text{ mm}$  1
- (d) Since the two wavelengths differ by 0.6 nm, the  
 interference patterns from these wavelengths will not  
 always overlap. } 1
- The interference pattern disappears when the dark fringes  
 from one of the wavelengths fall on the bright fringes of  
 the other. } 1
- The pattern reappears when the bright fringes from the  
 two wavelengths coincide again. } 1

4. (a)



straight line with  
-ve slope  
cuts t-axis at 50 s

1  
1

- (b) Theoretically, charge accumulated at uniform rate,  
 $V_C$  increases linearly;  $V_R$  drops linearly.

1  
1

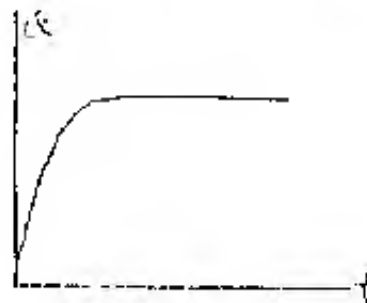
$V_R$  approaches a constant value means that the p.d. across  
the capacitor, and hence the charge stored in it, also  
becomes steady.

1  
1

At this stage, the current will not charge up the  
capacitor any further but will be all leaking away,  
i.e. an equilibrium state has been reached.

1  
1

(c) (i)



ordinary charging curve

1

achieves a constant  
value later

1

- (ii) At equilibrium,  $V_R = 2.4$  V  
P.d. across capacitor =  $(12 - 2.4)$  V  
= 9.6 V

1

Hence, charge stored on capacitor

$$= (500 \times 10^{-6})(9.6) \text{ C}$$

1

$$= 4.8 \times 10^{-3} \text{ C}$$

1

- (iii) Since p.d. across capacitor at equilibrium = 9.6 V  
and leakage current =  $120 \mu\text{A}$ .

$$\text{Leakage resistance} = \frac{9.6}{120 \times 10^{-6}} \Omega$$

1

$$= 80 \text{ k}\Omega$$

1

ALP-1486

3. (a) (i) The result shows that the induced e.m.f. in the search coil is proportional to  $1/r$ .  
 $\propto 1/r$  for a long, current carrying, straight wire.

1

(ii) When the distance of the search coil from the straight wire is comparable to the finite length of the wire, the induced e.m.f. is less than it should be for a infinitely long wire. Therefore, those data points lie above the fitted straight line.

1

1

(b) (i)  $B = \mu_0 I / 2 \pi r = \mu_0 I_0 \sin(2 \pi f t) / 2 \pi r$   
 $\text{emf} = N \lambda \frac{dB}{dt}$

1

$$= (\mu_0 N \lambda I_0 f / r) \cos(2 \pi f t)$$

1

$$V = 2 / \mu_0 N \lambda I_0 f / r$$

1

(ii) slope of line =  $1800 \text{ V}^{-1} \text{ m}^{-1}$

1

$$= 1 / (2 \mu_0 N \lambda I_0 f)$$

1

$$N = \frac{1}{2 \times 1.26 \times 10^{-6} \times 3.14 \times 10^{-4} \times 14.1 \times 50} \text{ turns}$$

1

$$\approx 1000 \text{ turns}$$

(c) His argument is wrong.

1

The earth's magnetic field is more or less a steady, low intensity field which would not give rise to any measurable induced e.m.f. in the search coil.

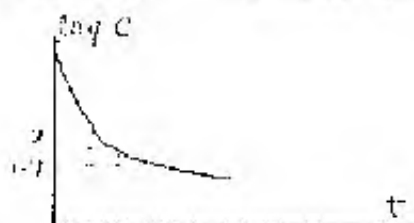
1

1

6. (a) After several days, the activity of iodine-133 has decreased to an insignificant level, leaving only the activity of iodine-131 to be shown up on the decay curve which when plotted on a log-scale, is a straight line.

1  
1  
1

(b)



$$\begin{aligned} N &= N_0 e^{-\lambda t} \\ \Rightarrow \text{slope of line} &= -\frac{\ln 2}{T} \log_{10} e \\ &= 0.375 \text{ day}^{-1} \end{aligned}$$

Extrapolate the straight portion to find the initial activity of I-131 to be  $10^2 = 100$  cpm.

find time corresponding to  $N = \frac{1}{2} \times 100$  or  $\log N = 1.7$ .

half-life of I-131 is 8 days.

$$\begin{aligned} T_{1/2} &= \frac{\ln 2 \times \log_{10} e}{0.375} \\ &= 8 \text{ days} \end{aligned}$$

- (c) (i) initial count-rate for I-131,  $C_1 = 10^2$  cpm  
initial count-rate for I-133,  $C_2 = 10^{2.9} = 10^2$  cpm  
 $= 694 \approx 700$  cpm

1  
1

(ii) count-rate  $= dN/dt = \lambda N$

knows  $C_1/C_2 = \lambda_1 N_1 / \lambda_2 N_2$

knows  $\lambda_1/\lambda_2 = T_2/T_1$

knows  $m_1/m_2 = 131 N_1 / 133 N_2$

1  
1  
1

$$m_1/m_2 = \frac{131}{133} \times \frac{N_1}{N_2}$$

$$= \frac{131}{133} \times \frac{C_1}{C_2} \times \frac{2}{1}$$

$$= \frac{131}{133} \times \frac{C_1}{C_2} \times \frac{T_1}{T_2}$$

$$= \frac{131}{133} \times \frac{100}{700} \times \frac{8 \times 24}{20.8}$$

$$= 1.30$$

1